Reconstruction of Severe Acetabular Bone Defects in Revision Hip Arthroplasty

Management options and clinical outcomes

STEFAN MOGOS[1,2], GEORGE VISCOPOLEANU[1]*, MONICA DASCALU[3], RADU ORFANU[1]

[1] Foisor Orthopedics Hospital Bucharest, 35-37 Ferdinand I Blvd., 021382, Bucharest, Romania

[2] Carol Davila University of Medicine and Pharmacy, 37 Dionisie Lupu 020021, Bucharest, Romania

[3] Politehnica University of Bucharest, 313 Splaiul Independentei, 060042, Bucharest, Romania

The objective of this study was to evaluate the effectiveness of different surgical implants for the reconstruction of severe acetabular bone defects in revision arthroplasty of the hip. The current study is a retrospective study on 32 patients with Paprosky type IIIA or IIIB acetabular defects operated between January 2012-December 2015 in a single hospital. The mean follow-up was 21 months (12-43 months). Five different types of reconstruction methods were used: primary uncemented cups with or without screws, cemented acetabular cups, tantalum cups, metal augments and antiprotrusio cages. Bone allograft was available in all cases. Functional outcome after surgery was evaluated using Harris Hip Score. Based on Paprosky classification, the study included 16 type IIIA and 16 type IIIB acetabular defects. Bone graft was used in 71.8% of the cases (23 out of 32 patients). Tantalum cups were used in 15 cases (46.9%), being the preferred implant. Primary uncemented cups were used in 2 cases, cemented acetabular cups were used in 4 cases, trabecular metal augments were used in 5 cases and antiprotrusion cages were used in 6 cases. The mean Harris Hip Score improved from 37.3±7.4 pre-operatively to 82.1±7.2 at final follow-up. In conclusion, the current study demonstrates that various methods of reconstruction are efficient in the short and medium-term.

Keywords: Revision, hip arthroplasty, bone graft, tantalum, bone defect

The number of total hip arthroplasties is increasing, as well as life expectancy. Consequently, the number and complexity of revision total hip arthroplasty continue to increase, with a further increase expected in 2030 of 137% compared to 2005 [1].

Revision hip arthroplasty is a technically demanding surgical procedure, particularly on the acetabular side, which is more commonly characterized by bone loss. The management of severe acetabular defects in revision hip arthroplasty is extremely challenging [2]. With the increasing number of revisions every year comes the need to find new and more effective methods of reconstruction of complex bone defects in order to provide long-term stability and restore hip biomechanics. The technology has undergone vast improvements and currently holds great promise and may potentially change the future of complex orthopaedic surgery [3-5].

The main treatment principles when dealing with severe acetabular bone loss during revision hip arthroplasty are represented by the restoration of the pelvic continuity, the restoration of the anatomical centre of the hip and of the femoral offset [6]. The complexity of the treatment is demonstrated by the numerous surgical options availiable, such as the use of uncemented or cemented acetabular cups, tantalum cups, oblong acetabular components, antiprotrusio cages, metal augments or allograft [7-13]. A custom made acetabular component based on a CT scan may be considered for obtaining increased mechanical stability in order to promote healing of the bony defect and to optimize biological integration of the implant [14]. However, currently there is no evidence to support the preferential use of any of these treatment options. The selected treatment depends mainly on the characteristics of the acetabular defect.

The objective of the current study was to evaluate the effectiveness of various surgical implants used for the reconstruction of severe acetabular bone defects in revision hip arthroplasty and to evaluate the clinical outcomes.

Experimental part

This is a retrospective study on 32 patients with Paprosky type IIIA or IIIB acetabular defects (25 females and 7 males) with a mean age of 64 years (with limits between 35 and 86 years) operated between January 2012-December 2015 in a single hospital. The mean follow-up was 21 months (12-43 months), with a minimum follow-up of 12 months for all the patients. The study was approved by the Institutional Review Board.

The acetabular bone defects were classified on the preoperative radiographs according to the Paprosky classification (fig. 1) and a confirmation was obtained intraoperatively. Of the 32 patients included in the study,

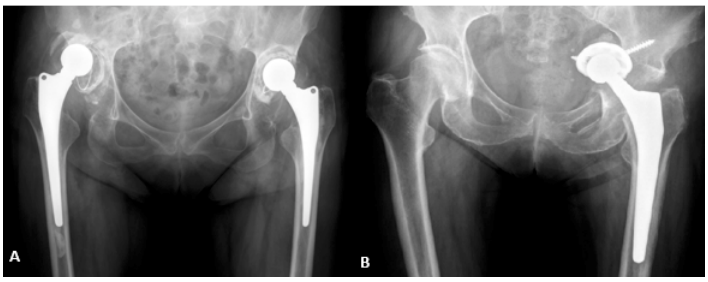

Fig. 1. 1A Paproski type IIIA acetabular defect, 1B Paproski type IIIB acetabular defect

* email: george.viscopoleanu@gmail.com; Phone: +4021.252.00.57

16 were classified as Paprosky IIIA and 16 as Paprosky IIIB. Pelvic discontinuity was present in 24 patients.

Patients with septic (4 patients) and aseptic loosening (28 patients) were included in the study. Five different types of reconstruction methods were used: primary uncemented cups with or without screws, cemented acetabular cups, tantalum cups, metal augments and antiprotrusio cages (fig. 2). Bone allograft was available for all cases.

Functional clinical outcome following surgery was evaluated using Harris Hip Score [15] which was obtained pre-operatively, and at follow-up visits at six weeks, three, six and twelve months and annually thereafter. Radiological evaluation was performed pre-operatively, the first day postoperatively, and at all follow-up examinations. The radiological examination protocol included a standard antero-posterior radiograph of the pelvis and lateral radiographs of the hip. On the preoperative radiographs the acetabular defects were evaluated according to Paprosky classification [16]. Postoperative radiographs were examined for the presence of radiolucent lines or signs of migration of the acetabular component. Loosening was defined radiologically as the presence of a radiolucent line of more than 1 mm in all three DeLee-Charnley zones, a change in the abduction angle of the acetabular component of more than 10°, or a change in the horizontal or vertical position of the acetabular component of more than 5 mm.

Surgical technique

All operations were performed in a laminar flow operative theatre. The patient was positioned in dorsal decubitus. A lateral Hardinge approach was used in all patients. The surgical procedure began by removing the failed acetabular component and any fibrous tissue and cement. The acetabular bone defect was then evaluated intraoperatively. The bony defect was shaped to a constrained cavity by using conventional reamers of increasing diameter. Morcellised bone allograft was used to fill the remaining defects in the acetabulum. No structural bone allograft was used. Trial antiprotrusio cages, trabecular metal augments and acetabular components were then positioned within the acetabular cavity to determine the optimal reconstruction configuration and component size. Final reconstruction of the acetabular defects was then accomplished using the five different methods mentioned above (fig. 3). Post-operative rehabilitation included partial weightbearing with the use of a walking aid for the first six weeks. Full weight-bearing was permitted after this time interval.

Results and discussions

Twenty four cemented and 8 uncemented implants were used. Bone graft was used in 71.8% of the cases (23 out of 32 patients). The preferred implant was the tantalum cup, which was used used in 15 cases (46.9%). Primary uncemented cups were used in 2 cases (6.3%), trabecular metal augments were used in 5 cases (15.6%), antiprotrusion cages were used in 6 cases (18.8%) and cemented acetabular cups were used in 4 cases (12,5%).

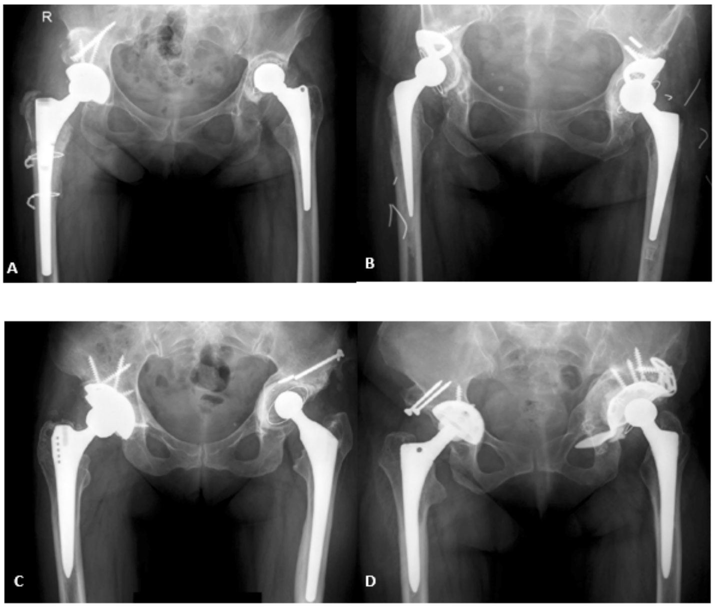

Fig. 2. 2A . Right hip revision with tantalum acetabular cup, 2B – Bilateral hip revision with tantalum augment and cemented acetabular cup, 2C – Right hip revision with tantalum augment and uncemented standard acetabular cup, 2D - Right hip revision with tantalum acetabular cup and left hip revision with antiprotrusio cage and cemented acetabular component

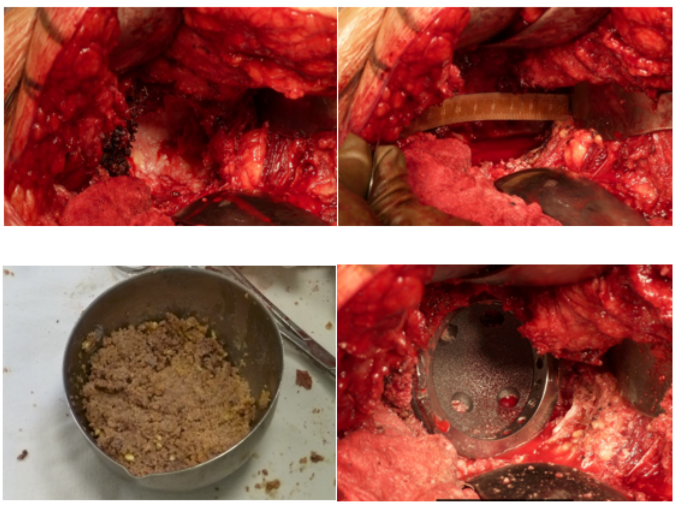

Fig. 3 Intraoperative views of acetabular revision with allograft and tantalum acetabular cup

The mean Harris Hip Score improved from 37.3±7.4 pre-op to 82.1±7.2 at final follow-up post-operatively. Concerning the pain subscale, pre-operatively 15 patients had severe pain, 14 had moderate pain, 2 had mild pain, and one had no pain. Post-operatively, 16 patients had no pain, 13 had slight pain and 3 had moderate pain. When considering support during walking, preoperatively 5 patients did not require a walking aid, 5 needed a stick for long walks, 18 needed full-time support with a walking frame or crutches and 2 patients were unable to walk. Postoperatively all patients were able to walk, 14 could walk without support, 8 needed a walking stick for long walks and 10 needed full-time support with either a walking frame or crutches. Concerning the limp subscale of Harris Hip Score, pre-operatively 21 patients had a severe limp, 8 had a moderate limp, 2 had a slight limp and one patient had no limp. Post-operatively, 5 patients had a severe limp, 10 had a moderate limp, 4 had a slight limp and 13 patients had no limp.

At final follow-up all components remained radiographically well fixed. There were no radiolucent lines or signs of migration of the acetabular component. There were no infections requiring removal of revision implants.

The main finding of the current study is represented by the fact that the various methods of acetabular reconstruction (tantalum cups, primary cups with or without screws, metal augments, antiprotrusio cages and cemented acetabular cups) are efficient in the short and medium-term. In the current study, the mean Harris Hip Score improved from 37.3±7.4 pre-op to 82.1±7.2 at final follow-up post-operatively. Adequate perioperative pain management may contribute to improved postoperative outcomes [17, 18]. The preferred implant for severe acetabular defects was the tantalum acetabular cup.

The Paprosky classification is meant to evaluate the severity of bone loss on AP radiographs of the pelvis, allowing the surgeon to choose the appropriate surgical option. With a severe acetabular defect there is often insufficient bone stock to support a standard acetabular component, and in these cases alternative techniques and implants, such as tantalum cups, primary cups with or without screws, metal augments, antiprotrusio cages and cemented acetabular cups, are needed. The goal of revision acetabular reconstruction should be to obtain a stable fixation with restoration of the hip centre.

Lingaraj et al. [19] demonstrated that modular porous metal components are a viable option in the reconstruction of Paprosky type 3 acetabular defects, with the mean Harris Hip Score improving from 43,0 pre-operatively to 75.7 post-operatively. Sporer et al. [20] showed that the treatment of type IIIB pelvic discontinuity during acetabular revision using a trabecular metal acetabular component with or that without an associated trabecular metal augment appears to provide reliable and reproducible short-term results. Fletcher et al. [21] demonstrated in their study that trabecular metal components appear suitable to achieve primary stability in type III acetabular defect as an alternative to bone graft and cages. Moreover, Friedrich et al. [9] showed that the treatment of acetabular bone loss and pelvic discontinuity with a custom-made acetabular component can provide a durable solution with good clinical and radiographic results. Their findings are similar to the ones obtained in our study, demonstrating the importance of the complex acetabular reconstruction for type III Paprosky bone defects.

The main limitation of the current study is represented by short follow-up period. Longer follow-up is necessary for confirming the encouraging short and medium term results obtained with complex acetabular reconstruction techniques for type III acetabular defects.

Conclusions

The current study demonstrates that various methods of reconstruction are efficient in the short and medium-term. Yet, they must be carefully chosen depending on the characteristics of the acetabular bone loss. The preferred implant for severe acetabular defects is the tantalum cup. Bone graft should be available before considering revision for a Paprosky type III defect.

References

1.KURTZ, S., MOWAT, F., ONG, K., CHAN, N., LAU, E., HALPERN, M., J Bone Joint Surg, **87**, no. 7, 2005, p. 1487–1497

2.KURTZ, S., ONG, S., ONG, K., LAU, E., MOWAT, F., HALPERN, M., J Bone Joint Surg Am, **89**, no. 4, 2007, p. 780-785

3.MILEA, P.L., DASCALU, M., OPRIS, C.O., FRANTI, E., DUMITRACHE, M., STOICA, C.I., Using pressure sensors for motion detection and actuation of remote manipulation devices, Romanian Journal of Information Science and Technology, **19**, no. 4, 2016, p. 321-330

4.FRANTI, E., MILEA, L., BUTU, V., CISMAS, S., LUNGU, M., SCHIOPU, P., BARBILIAN, A., PLAVITU, A., Methods of Acquisition and Signal Processing for Myoelectric Control of Artificial Arms, Romanian Journal Of Information Science And Technology, **15**, no. 2, 2012, p. 91-105

5.BANERJEE, S., KULESHA, G., KESTER, M., MONT, M.A., J Knee Surg, **27**, no. 3, 2014, p. 185-91

6.GRAVIUS, S., RANDAU, T., WIRTZ, D.C., Orthopade, **40**, no. 12, 2011, p. 1084–1094

7.BERRY, D.J., Clin Orthop Relat Res, **420**, 2004, p. 106–112

8.FRIEDRICH, M.J., GRAVIUS, S.,, SCHMOLDERS, J., WIMMER, M.D., WIRTZ, D.C., Oper Orthop Traumatol, **26**, no. 2, 2014, p. 126–140

9.FRIEDRICH, M.J., SCHMOLDERS, J., MICHEL, R.D., RANDAU, T.M., WIMMER, M.D., KOHLHOF, H., WIRTZ, D.C., GRAVIUS, S., Int Orthop, **38**, no. 12, 2014, p. 2455-61

10.MURPHY, S.B., J Arthroplast, **20**, 2005, p. 200585–90

11.BECKMANN, N.A., WEISS, S., KLOTZ, M.C., GONDAN, M., JAEGER, S., BITSCH, R.G., J Arthroplasty, **29**, 2014, p. 229–235

12.BANERJEE, S., ISSA, K., KAPADIA, B.H., PIVEC, R., KHANUJA, H.S., MONT, M.A., Int Orthop, **38**, 2014, p. 689–702

13.GUNTHER, K.P., WEGNER, T., KIRSCHNER, S., HARTMANN, A., Oper Orthop Traumatol, **26**, 2014, p. 141–155

14.CHRISTIE, M.J., BARRINGTON, S.A., BRINSON, M.F., RUHLING, M.E., DEBOER, D.K., Clin Orthop Relat Res, **393**, 2001, p. 216–227

15.HARRIS, W.H., J Bone Joint Surg [Am], **51**, no. 4, 1969, p. 737-55

16.PAPROSKY, W.G., PERONA, P.G., LAWRENCE, J.M., J Arthroplasty, **9**, 1994, p. 33-44

17.MUNTEANU, A.M., CIONAC-FLORESCU, S., ANASTASE, D.M., STOICA, C.I., Is there any analgesic benefit from preoperative vs. postoperative administration of etoricoxib in total knee arthroplasty under spinal anaesthesia?: A randomised double-blind placebo-controlled trial, Eur J Anaesthesiol, **33**, no. 11, 2016, p. 840-845

18.HOJER-KARLSEN, A.P., GEISLER, A., PETERSEN, P.L., MATHIESEN, O., DAHL, J.B., Pain, **156**, no. 1, 2015, p. 8-30

19.LINGARAJ, K., TEO, Y.H., BERGMAN, N., J Bone Joint Surg Br, **91**, no. 12, 2009, p. 1555-60

20.SPORER, S.M., PAPROSKY, W.G., J Arthroplasty, **21**, 2006, p. 87-90

21.FLECHER, X., SPORER, S., PAPROSKY, W., J Arthroplasty, **23**, no. 7, 2008, p. 949-55

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